OHIO BRASS MANAGEMENT REPORT

HE LEFT ROUTE 25 AND DISCOVERED DYNAGAP

BY GEORGE L. DRAFFAN
CHAIRMAN, OHIO BRASS COMPANY

The development engineer knew where to get off Route 25. That would be my simple explanation of the way that many significant improvements in product design are achieved. Someone has the courage to discard the route of habit and to try the route of reason.

THE REFERENCE TO ROUTE 25 is drawn from the experience of the late Charles F. (Boss) Kettering who came from our part of Ohio. He told about the young assistant who didn't believe Kettering could drive from Detroit to Dayton in four and one-half hours. So the Boss proceeded to prove it could be done.

"NO WONDER," exclaimed the assistant, "you didn't stay on Route 25." This was the story Kettering used to urge engineers to break away from conventional thought patterns.

FOR MANY YEARS our industry had a Route 25 approach to lightning arrester design because it thought the only way to a better product was through improvements in the valve element. But this approach depended on improvement in block materials, and these came slowly.

THEN AN O-B ENGINEER DECIDED to leave Route 25 and to find another route for performing the same function. The result was the Dynagap, introduced five and one-half years ago in 1957. I won't go into technical detail other than to point out that most of the severe duty formerly imposed on the valve block is now handled by the series gap.

THE SIGNIFICANCE OF THIS development has extended far beyond improved protective features in the arrester. It has meant substantial savings in capital investment that completely dwarf the cost of the arresters themselves.

FOR EXAMPLE, OVER-ALL SUBSTATION cost has been lowered considerably for the utility that uses Dynagap arresters. It is now possible to drop basic insulation levels for transformers in 138-kv stations from 650 to 450 kv; in 230-kv stations from 1050 to 750 kv; and in 345-kv stations from 1300 to 1050 kv, and there are plans to go to 900. These BIL reductions of as much as 30 per cent are directly reflected in lower transformer costs.

IN TERMS OF SUBSTATION real estate and steel, the Dynagap has brought other sizable savings. The miniaturized arrester takes less space and the simplest of mounting arrangements compared with the elaborate supporting methods required previously.

THESE ARE JUST A FEW of the benefits. The savings have piled up rapidly for utilities that chose to use Dynagap. I hope your Company is among them. If it isn't, I understand that a few Dynagap arresters are still available.

712-H

OHIO BRASS COMPANY, MANSFIELD, OHIO
Porcelain Insulators—Line Hardware—Capacitors—Lightning Arresters
Bushings—Holan Truck-Mounted Power Devices & Bodies—Bronze Valves

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RIV testing at O-B high-voltage outdoor laboratory. (See page 2)

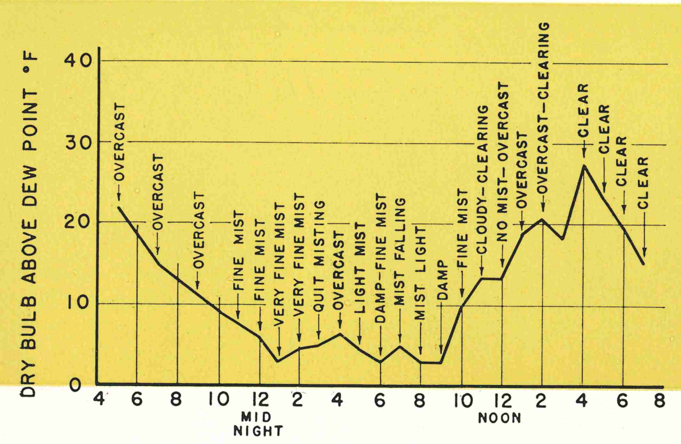
PUBLISHED BY OHIO BRASS COMPANY, MANSFIELD, OHIO VOL. 32, NO. 1 JANUARY 1963

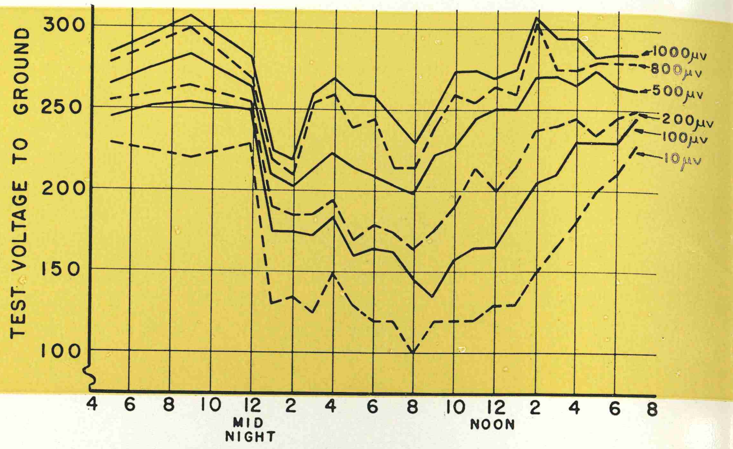
HI-TENSION NEWS

1888-1963 Our 75th Year of Serving Customer Needs lab studies shed more light on familiar problem . . .

WEATHER OVERRIDES CONTROL RINGS IN DETERMINING RIV LEVELS

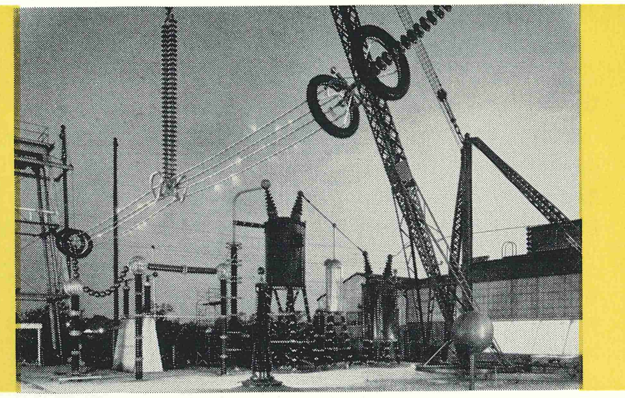
Continuous 26-hour test in outdoor lab records hourly variations in radio influence voltages



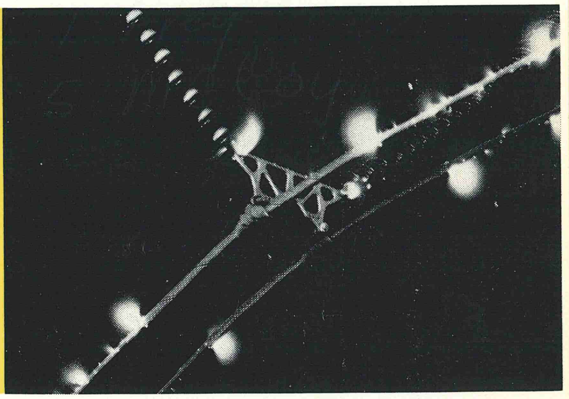


Variation of radio influence voltage generation during a 24-hour outdoor test on a 345-KV V-string assembly. At the RIV coordination voltage of 220 KV, the radio influence voltage varied from a minimum of less than 10 microvolts to a maximum of approximately 800 microvolts during the test series. Tests of this nature have served to indicate the futility of attempting fine coordination of RIV properties on indoor laboratory tests.

RIV test setup on four-conductor bundle in O-B high-voltage outdoor laboratory. Transformer set in background can supply up to 1500 kv RMS to ground.



Outdoor test setup during RIV demonstration tests on 345-KV V-string assembly. This assembly will be used on a 345-KV line in an area subject to hurricane winds. The yoke plate is thus proportioned to permit partial collapse of the "V" and a slack insulator string on the leeward side without interference between the porcelain and metal parts. Conductor is energized at 400-kv to ground in this test (equivalent to a system voltage of 690-kv).



One of the welcome features of bundle-conductor transmission was the early discovery that the conductors themselves performed some of the shielding functions formerly assigned to electrostatic stress control rings at support points.

Editor's Note

An article in the December, 1962, issue of Hi-Tension News, "New EHV Bundle Conductor Hardware Eliminates Control Rings," pointed out a few of the reasons why control rings may no longer be required on many HV and EHV transmission lines. The following article, based upon a paper recently presented before the Pennsylvania Electric Association, shows the results of additional laboratory studies on the same subject. Copies of the full paper, "Development of Insulators and Hardware for 500-kv Stations and Lines," by A. D. Lantz, are available on request.

Not unexpectedly, early EHV bundle-conductor lines did not take full advantage of this discovery.

The industry's limited experience with conductor bundles necessarily limited technological development; and the builders of the new lines, quite logically, preferred conservative designs which would keep radio influence levels (RIV) at or near levels with which they had previous satisfactory experience.

This explains why some of the earliest twin-bundled 345-kv lines were designed to produce even less RIV than an existing single-conductor 230-kv line in the same area.

Design criteria in regard to RIV levels became somewhat less conservative, however, as the industry acquired more experience with multiple conductors and as manufacturers acquired more extensive test data on the RIV performance of different conductor configurations under various atmospheric conditions.

A significant departure from earlier RIV test procedures was initiated by Ohio Brass as a result of studies undertaken for the prototype 460-kv line of Pennsylvania Electric Company.

Up to this time, manufacturers' RIV tests had generally been confined to indoor laboratories, in whose "semi-controlled" atmosphere some correlation could be established between day-to-day tests intended to reveal the different performance characteristics of slightly different conductor configurations and conductor support assemblies.

Such correlations would have been impossible if tests had been run outdoors through several days or weeks of erratic weather conditions.

While the results of indoor tests were not expected to correspond with results obtained in actual field service, long experience in both areas had provided adequate lab-field correlations to enable engineers to recognize acceptable or non-acceptable performance characteristics.

During the course of the Penelec 460-kv tests, it became apparent that radio influence voltage curves were much more sensitive to relative humidity than had been evident up to that time. Later analysis indicated the cause to be minute leakage currents over the insulator surfaces, resulting from the presence of otherwise undetectable surface moisture films.

After reviewing other types of tests within the laboratory, it was concluded that measurable surface conductivity could be observed on glazed porcelain surfaces when the relative humidity exceeded about 40 per cent.

This finding prompted further investigations -- among them an attempt to measure, under closely controlled laboratory conditions, the precise effect of weather variations on RIV levels.

The measurements were made over a 26-hour period at the O-B high-voltage outdoor laboratory on a prototype 345-kv V-string insulator assembly (without control rings) supporting a twin-conductor bundle. The conductor was energized continuously for the entire period at 220 kv RMS to ground.

Every hour on the hour a voltage run from 100 kv to over 300 kv was made. During each run, lab engineers plotted the exact voltage level required to produce RIV levels of 10, 100, 200, 500, 800, and 1000 microvolts on the conductor support assembly. Simultaneous recordings were made of atmospheric conditions during each voltage run.

The results of the 26-hour test are shown in the accompanying graphs, which provide an hourly correlation of humidity and atmospheric conditions with RIV levels at voltages from 100 kv to 300 kv.

Note, for example, that at the test voltage level of approximately 220-kv, radio influence voltage increased from 10 microvolts to almost 1000 microvolts in a one-hour period from 12 midnight to 1 p.m. (shortly after a light mist began to fall).

Note also the close correlation between RIV levels and degrees temperature above the dew point during the test period.

At times during the test, rings were added and voltage runs were made to establish relative RIV characteristics for the set with and without rings. While the rings always produced a slight improvement, the weather conditions proved to be the overriding effect and to such an extent that rings were of no great significance in limiting the general production of RIV. In general, indoor tests would be expected to produce results comparable to the first few hours shown for the outdoor results.

The experiment shows that while RIV tests in "semi-controlled" indoor atmospheres may be of great value to development engineers, they have only limited usefulness for the transmission design engineer.

HOLAN'S NEW LD-42 FEATURES COLOR-CODED DISC CONTROLS

Single-Bucket Elbow Has Wide Operation Range, Speed, Stability

Among the many design innovations offered on Holan's new LD-42 Elbow, none is more revolutionary than the color-coded control and emergency stop discs.

Easy to reach, the disc controls are mounted between the bucket and upper arm and control all Elbow action. Levers -- which are more likely to snag -- are thus eliminated.

The emergency disc is red, is the largest of the four, and is mounted nearest to the arm. Any accidental contact is more likely to be made by this large disc than any of the others. Such contact stops all movement, locks the hydraulic system.

Closest to the bucket is the orange disc for unit rotation; the blue disc controls lower arm action; the yellow controls upper arm action.

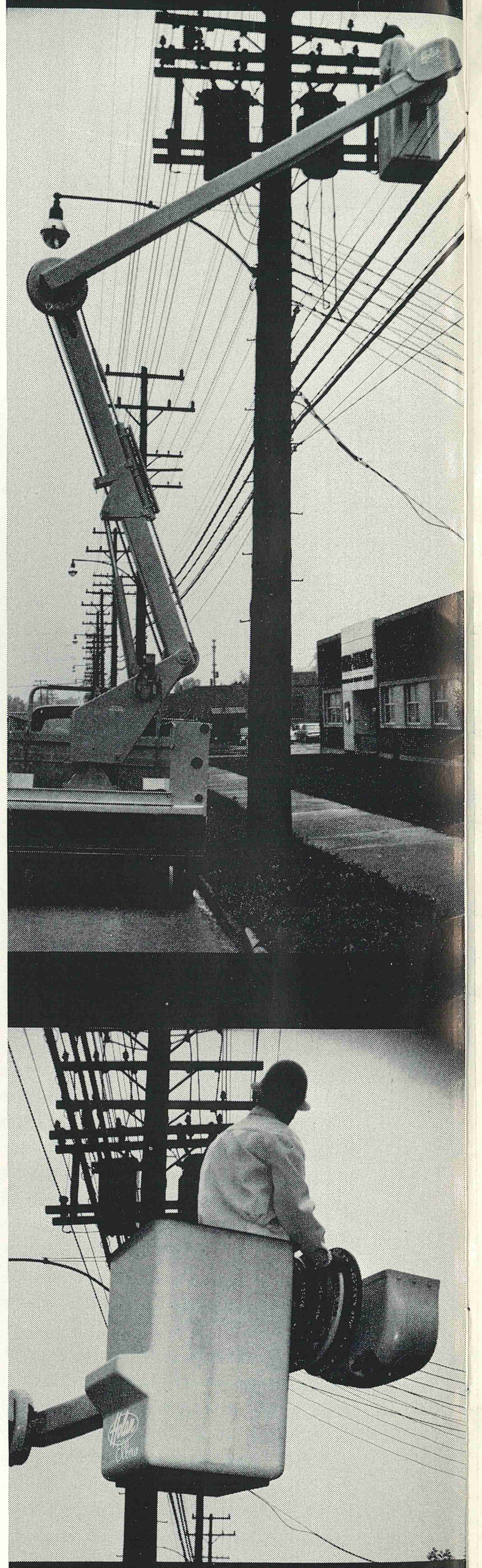
Linemen using the 42-foot Elbow find few "impossible" aerial positions. That's because of the 110-degree lower arm travel and 270-degree upper arm travel. Also adding to the versatility of the hydraulically actuated Elbow is an upper arm which is 27 inches longer than the lower arm.

The unit rotates 400 degrees in either direction and will reach out 29 feet, 7 inches and provides a 6-foot working position below ground.

No outriggers are needed to position the 300-pound payload anywhere in the operating range. Holan's torsion bar system and exclusive reverse offset superstructure make them completely unnecessary, even when the Elbow is mounted on a truck with an 84-inch CA chassis.

The upper arm is fabricated principally of high dielectric fiberglass reinforced plastic and provides 116 inch of bucket-to-ground insulation at 8000 volts/inch dry flash-over. The homogeneous one-piece construction of square tubular design is wound on a mandrel in such a way that air pockets and voids are eliminated. The resultant arm is not brittle nor sentitive to notching and scratching.

For more details write Holan Corporation, 4100 West 150th Street, Cleveland 35, Ohio. Holan is a wholly owned subsidiary of The Ohio Brass Company.



Torsion bars and reverse offset superstructure design keep the LD-42 Elbow level at all times. Fast-acting, the unit swings 360 degrees in 60 seconds; the lower arm elevates through 110 degrees in 80 seconds; and the upper arm moves 270 degrees in 160 seconds.

THEY'RE COMPATIBLE

O-B's two lines of stacking posts go together; both can be used in same station without penalty of extra inventory

Use both in the same yard and maintain Uniposts and small-end stacking posts with one kind of a unit plus an adapter plate.

Shown are two types of O-B stacking posts: Unipost (one kind of an insulator) and the small-end stacking post. They're compatible; Unipost units can be interchanged unit for unit in either stack. And, complete stacks can be interchanged. Check the dimensions of O-B stacking posts of your BIL right here.

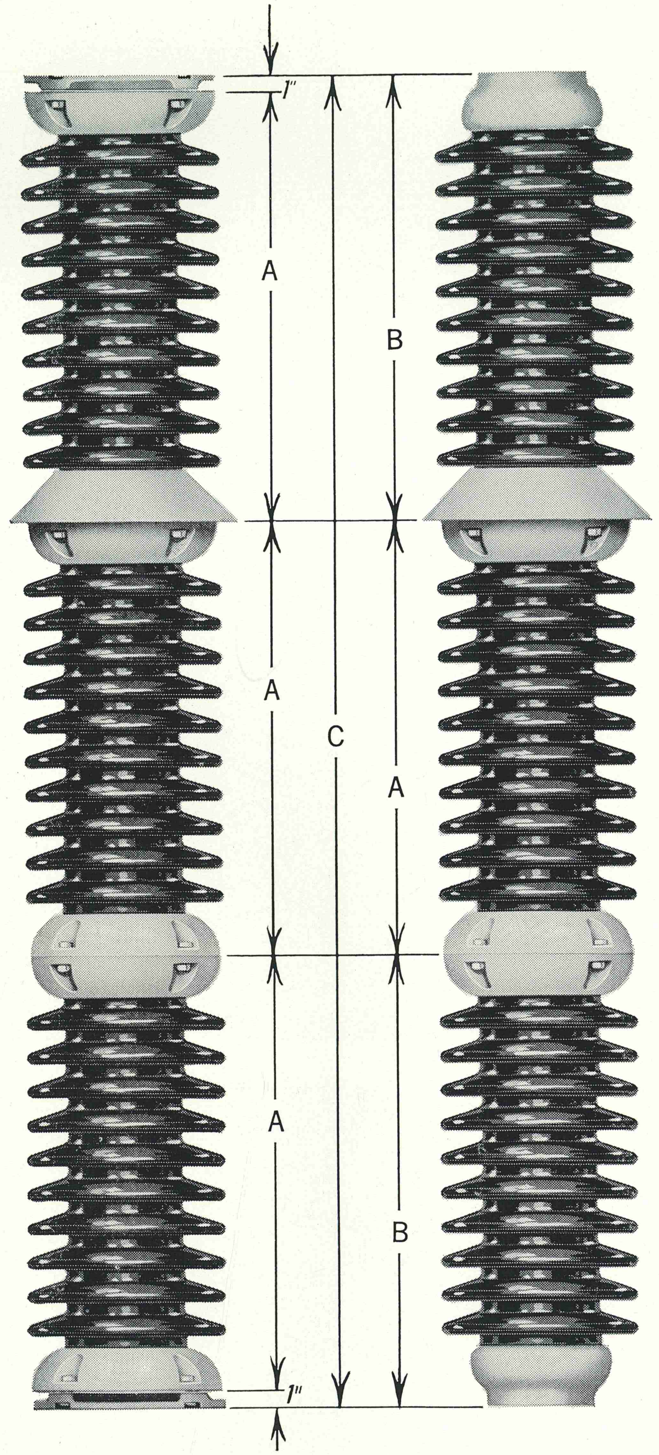
All Unipost units for a given BIL stack are alike in height. This is dimension "A" in the drawing. Note, too, that the center units of small-end stacking posts are the same as the Unipost units.

The top and bottom units ("B") of the small-end stacking post measure just one inch longer than the Unipost units. Uniplates add an inch at top and bottom of the Unipost making the over-all height ("C") of both stacks identical.

Uniplate also permits the Unipost to conform to the small diameter bolt circles of the pincap and small-end stacking post.

Both types of stacking posts enjoy the same flashover values, withstand voltages and radio influence voltages. They are mechanical equivalents in torsion, tension, compression, and cantilever strengths as well as leakage distance and arcing distance.

Both stacking posts are available in standard, high, and extra-high strength ratings and in the same ranges of basic impulse insulation level.



BIL	C STACK Height	A Unipost Unit	B Specialized End Unit
KV	in.	in.	in.
450	38	18	19
550	45	21½	22½
650	54	26	27
750	62	30	31
825	75½	24½	25½
900	80	26	27
1050	92	30	31
1175	100	24½	25½
1300	106	26	27
1470	122	30	31

WHAT IT TAKES TO DEVELOP A BUSHING

O-B laboratory subjects new bushing designs to thorough and unusual electrical tests

Can you prove it? That's the question all good utility buyers should and do ask of manufacturers of new equipment. The answer from O-B will be an emphatic yes.

The O-B laboratory runs many tests, some of which are quite unusual, to help the design engineer prove his bushing design for adequacy and long life. These tests examine the bushing in a matter of days to tell more than can possibly be discovered in months or years of another method.

Today we can point to an enviable service record among bushing manufacturers to prove that O-B condenser bushing designs are sound. Of the more than 50,000 O-B condenser bushings in service the failure rate to date still stands at zero. This record is not just good fortune but results from a lot of hard work done in the O-B laboratory.

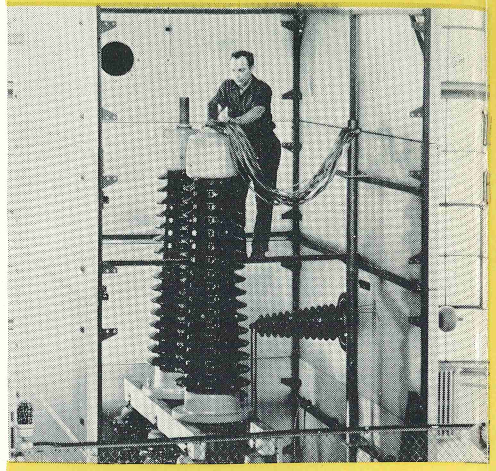
For our discussions here, let's divide O-B testing into three phases. One includes all electrical design tests involving primarily dielectric strength. The second testing phase includes mechanical tests of cantilever strength and dynamic loading. Third of the three phases is the standard production tests conducted on every O-B bushing before shipment.

Production testing generally checks each product to see that the design has been faithfully reproduced. But design tests often go to total destruction just to learn what actual limits have been built into the product; they seldom leave the specimen in safe serviceable condition.

O-B design tests include 60-cycle withstand and flashover; all tests necessary to establish a volt-time curve from critical impulse flashover to steep wave impulse flashover; and fractional-microsecond pre-flashover corona studies under steep wave. Prolonged high current heating characteristics are investigated and precise radio noise and ionization tests are conducted with some of the most sensitive equipment available.

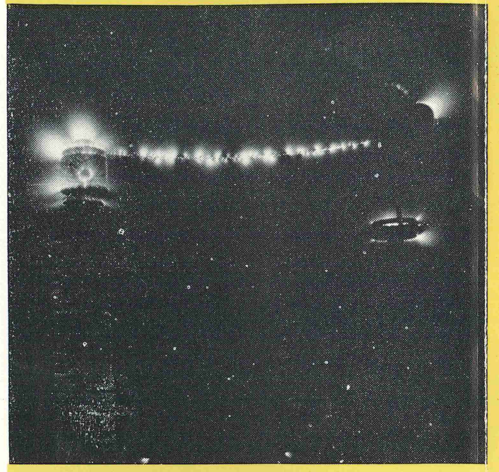
Many of the above electrical tests help reveal characteristics of the bushing's electrostatic field. However, one unique method of studying the electrostatic field includes probing with a sensing device around an energized bushing. Another method is the wax-imbedded metal-template test that accurately reveals the shape of the field through its cross section.

You may recognize in the accompanying pictures some of the types of O-B bushings used in your transformers or circuit breakers. But, these bushings never filled an order. Although they "graduated" from the electrical design study, they found their way to the scrap pile - or to a storeroom of curiosities. That's the price they pay to keep O-B's record clean.



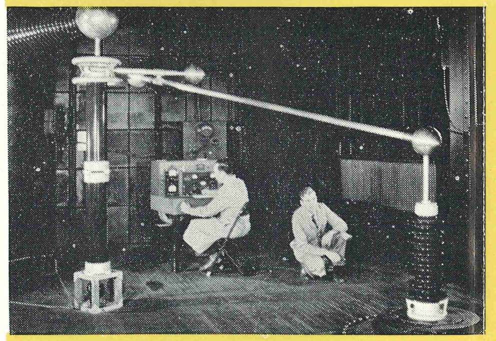
1

1. High current heat tests are run in this insulated enclosure, which is sealed airtight after the specimens are prepared. Temperature within the chamber is brought to a high ambient and maintained for a long time while heavy currents are applied. Numerous remote reading thermocouples record the bushing's behavior. This thorough study of the bushing's thermal characteristics enables O-B to design interchangeable bushings for use in transformers or circuit breakers without reduction of continuous current rating.



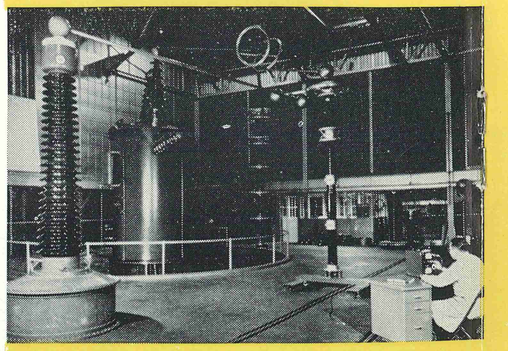
2

2. Corona studies in wet conditions at highly elevated 60-cycle voltage. Charged metallic components of the bushing, as would be expected, are violently active. Lack of concentrated electrical stress over entire porcelain area of bushing indicates design has stress well under control.



3

3. Radio noise tests not only search for radio interference levels but also make it possible to predict potential life by finding the starting level of internal corona and ionization control in the bushing. This is a 200-kv test set-up for the smaller condenser bushings and employs sensitive RIV equipment.



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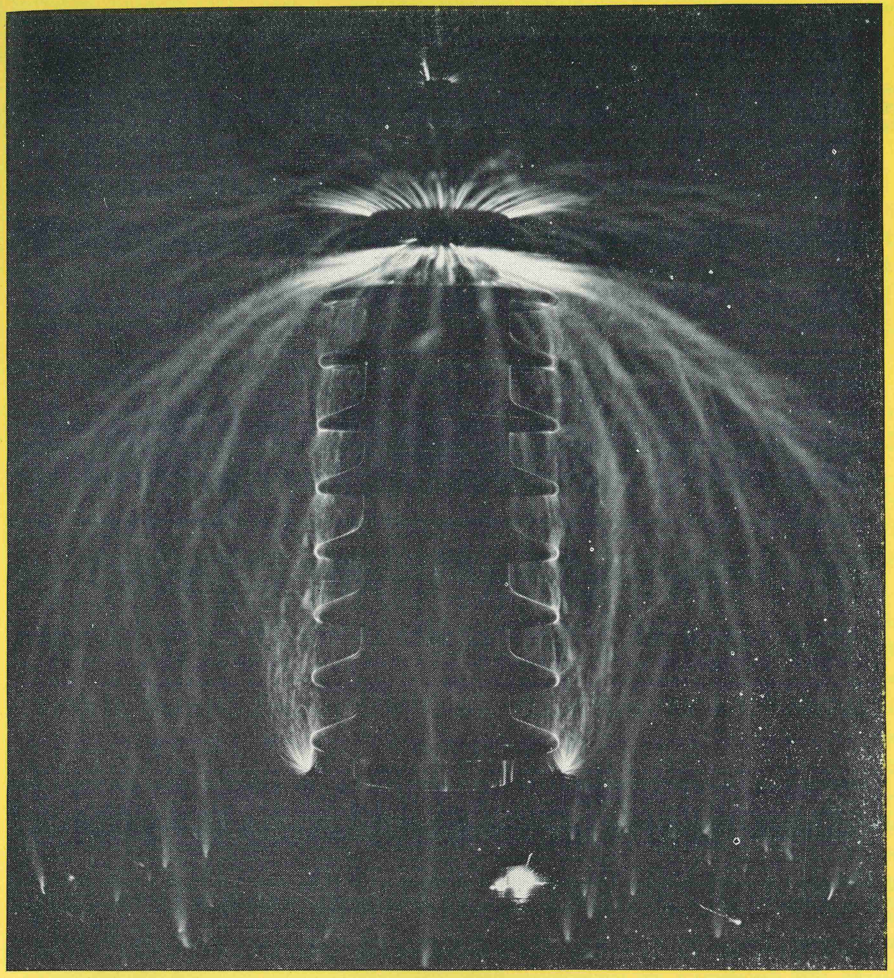
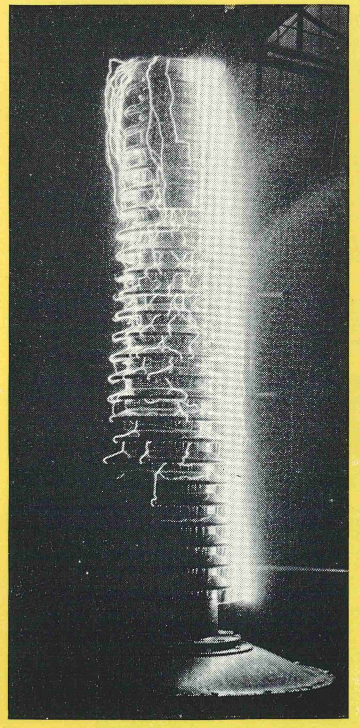
4. A 345-kv bushing undergoes radio noise tests in one of the laboratory's test bays. Even O-B's EHV bushings show exceptional quietness in RIV tests.



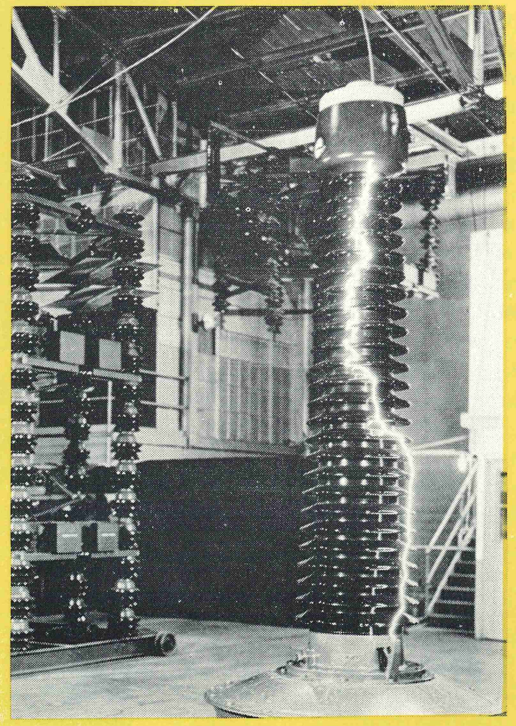
5

5. Steep wave impulse stress - the instant preceding flashover. The corona pattern in this highly unusual and difficult test is totally invisible to the eye but can be accurately recorded for study by photography. The corona clearly shows the influence of the electrical field and locates points of stress concentration. The bushing deserves a great deal of credit for surviving ultra-steep wave fronts used here.



6

6. Sixty-cycle tests are generally prescribed as "withstands." O-B's tests search for the maximum voltage a design can take. Here the bushing was subjected to increasing voltage in standard rain conditions until flashover.



7

7. Two-million volt impulse generator delivers steep wave surge to 1300-kv BIL bushing. Standards specify a surge as 1½ x 40 microsecond test wave. The O-B impulse generator can produce discharges with a wave front of 8,000 kv per microsecond - far more destructive than even natural lightning.

EQUIPMENT REQUIREMENTS FOR THE LIVE LINE METHOD

An excerpt from AIEE Conference Paper 62-1483 of the same title presented by C. J. Miller, Jr. at Chicago May 8, 1962. Copies of the full paper (15 pages) are available on request. Ask for O-B Publication Number 1530-L.

The basic insulation to ground must be able to sustain its rated power frequency voltage continuously without any damage to the insulating material of which it is made, and in addition it must be able to withstand switching surge voltages which may reach as high as three times the rated line-to-ground crest voltage.

1. THE INSULATING SECTION

In the elbow-type aerial lift, the basic insulation to ground is generally provided by a suitable tubular fiberglass insulating section built into the upper arm between the personnel buckets at its upper end, which operates at line potential, and the supporting metal section at its lower end, which is generally operated at or near ground potential, as is illustrated schematically in the accompanying sketch.

In addition to the main fiberglass section, there may be a number of insulating rods or oil-filled hydraulic lines essential to the proper operation of the equipment which cross the insulating section and, therefore, which must also be considered as an integral part of the basic insulation to ground.

2. VOLTAGE RATING

The voltage rating that may be assigned to an aerial lift is dependent upon the minimum effective length of the insulating section. For aerial lifts in which the insulating leveling and control rods may move longitudinally for different configurations of the elbow, it is essential that the minimum effective length be determined for the maximum offset position of these insulating rods.

As a result of laboratory tests and other practical considerations, the basic insulation levels shown in Table I have been established for the purpose of assigning voltage ratings to aerial equipment intended for the practice of the live line barehand method. The basic insulation levels in this table are based upon an average line-to-ground voltage rating of about 20 kv per foot of effective insulating section, with the exception that a minimum length of 3 feet has been specified for 0-69 kv system voltages in order to place the grounded end of the insulating section at a safe distance beyond the normal reach of the lineman in the bucket. The minimum effective length for voltage levels other than those listed in Table I may be obtained by interpolation.

As indicated in the note appended to Table I, the minimum effective length of the insulating section by itself is not sufficient to insure the adequacy of the basic insulation level. Laboratory tests indicate that suitable control of the electric field at each end of the insulating section is essential, in order (1) to avoid at rated voltage sustained electrical discharges which might lead to a deterioration of the insulation and (2) to avoid the occurrence of switching surge flashovers at a voltage level far below the withstand voltage which is compatable with a properly designed insulating section of given length. *Laboratory tests indicate that the longer the length of the insulating section the more important becomes the need for the proper control of the electric field, if a withstand voltage level compatible with its length is to be realized.*

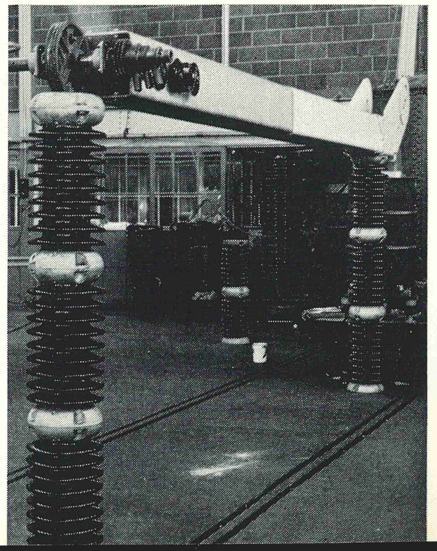
3. QUALITY OF THE INSULATION

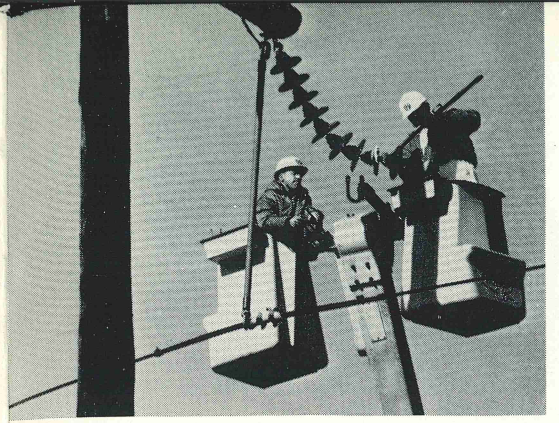
The insulating section of the upper arm may frequently be required to sustain an average operating voltage gradient of 20 kv RMS per foot for extended periods of time, and momentary voltage gradients as high as 60 kv RMS per foot resulting from switching surges. To meet this requirement, it is essential that the intrinsic dielectric properties of the insulating material be adequate to sustain such gradients, and this would appear to imply a high degree of freedom from voids within the body of the dielectric material itself. It is a well known phenomenon that electrical discharges occurring in voids in an organic insulating material may lead to progressive electrical failure, especially where the direction of the electric field is parallel to these voids.

Laboratory tests have shown that a properly manufactured fiberglass tube is capable of withstanding longitudinal voltage gradients of more than 100 kv RMS per foot for extended periods of time without any detectable deterioration of its dielectric properties.

Based upon the foregoing requirements and capabilities, a withstand voltage gradient of 70 kv RMS per foot for one minute without deterioration or flashover has been selected as the criterion for judging the adequacy of the dielectric material comprising the insulating section.

A heated calcium chloride-laden fog is introduced into the upper arm of a Holan elbow to permit studies of leakage currents on the interior of the fiberglass insulation section.





Replacing a defective unit in a suspension insulator string of an energized 161-kv transmission line on a wooden H-frame structure. Note that the energized conductor is temporarily supported on a link stick.

Unless the dielectric material of the insulating section can meet this criterion it should not be rated for use with the live line barehand method in accordance with Table I.

4. LEAKAGE CURRENT

When both the inner and outer surfaces of the insulating section are clean and dry, it has been demonstrated that the surface leakage current along its length is practically non-existent. On the other hand, laboratory tests show that when these surfaces become contaminated and wet, a leakage current of appreciable magnitude can flow in the resulting conducting film.

If this leakage current becomes large enough, there is the possibility that permanent damage might occur to the material of the insulating section.

In addition to leakage current on the surface of the fiberglass insulating section, there is also the possibility of leakage current on the exterior surface of each of the various insulating rods or hydraulic hose lines crossing the insulating section, provided these surfaces become contaminated and wet. In the case of a hydraulic line, there is the added possibility of conduction through the hydraulic fluid itself should it become contaminated or wet.

Because of the potential hazards that could result from leakage current, it is essential that proper means be taken in the design as well as in the use of the equipment to control the magnitude of the leakage current across the insulating section to keep it within safe limits.

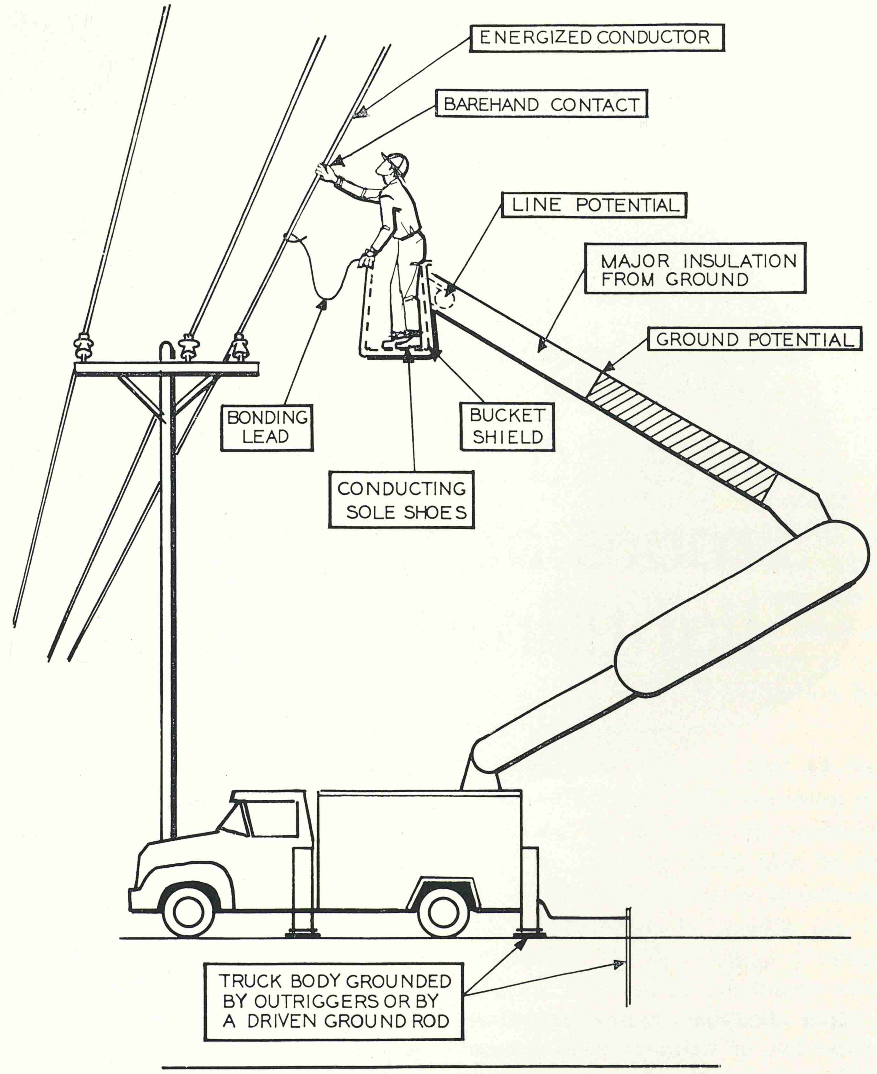


TABLE I

BASIC INSULATION LEVELS FOR AERIAL EQUIPMENT INTENDED FOR USE WITH THE LIVE LINE BAREHAND METHOD

NOMINAL SYSTEM VOLTAGE RMS KILOVOLTS LINE-TO-LINE	MINIMUM EFFECTIVE LENGTH * OF THE INSULATING SECTION, FEET	ONE MINUTE WITHSTAND TEST 60-CYCLE RMS KILOVOLTS LINE-TO-GROUND
0-69	3	80
138	4	160
230	7	265
345	10	400
500	14	580
750	22	870

* Length alone does not insure the adequacy of the basic insulation level. These section lengths provide an adequate insulation level only when

(1) suitable control of the electrostatic field is provided at each end of the insulating section, and

(2) the insulating material itself is capable of meeting a withstand voltage gradient test of 70 kv RMS per foot for one minute without any deterioration.

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HE LEFT ROUTE 25 AND DISCOVERED DYNAGAP

BY GEORGE L. DRAFFAN
CHAIRMAN, OHIO BRASS COMPANY

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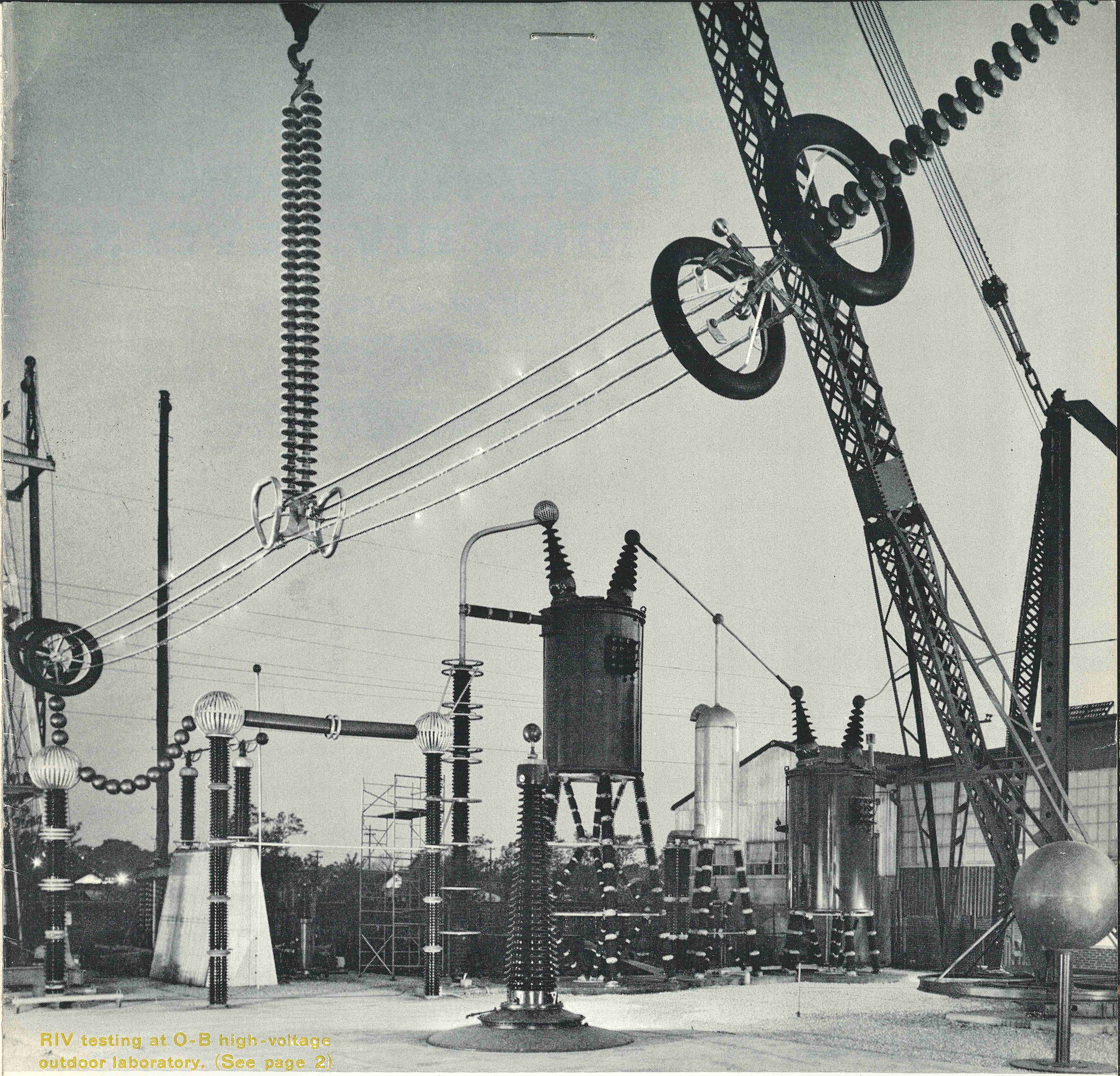

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